Piezoelectric transformers: Control

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Publication date:
2017

Document Version
Peer reviewed version

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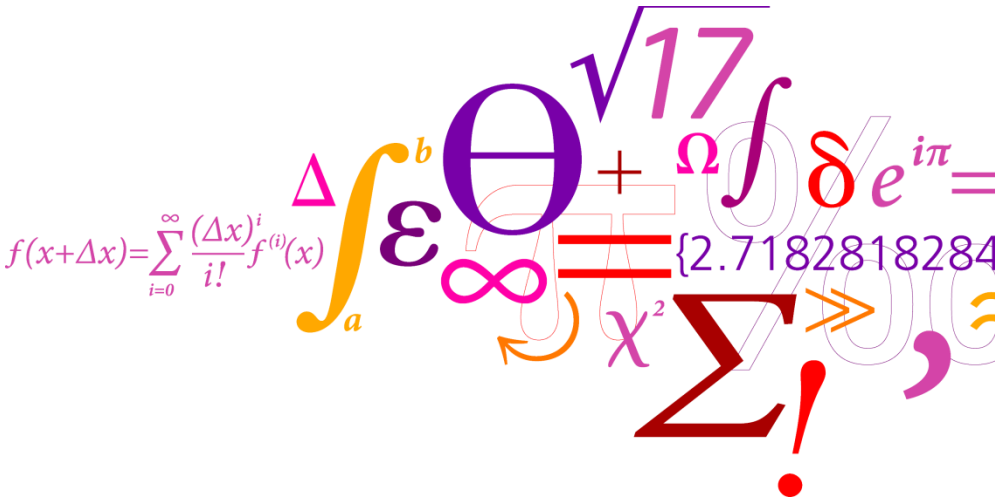
Gabriel Zsurzsan, Michael A.E. Andersen, Nils Axel Andersen,
Zhe Zhang

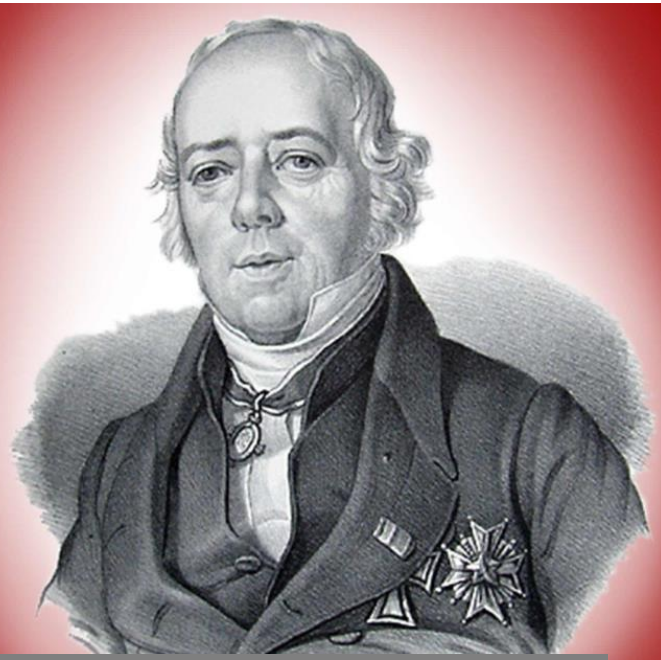


DTU Electrical Engineering
Department of Electrical Engineering

Technical University of Denmark - DTU

DTU will develop and create value using the natural sciences and the technical sciences **to benefit society**.

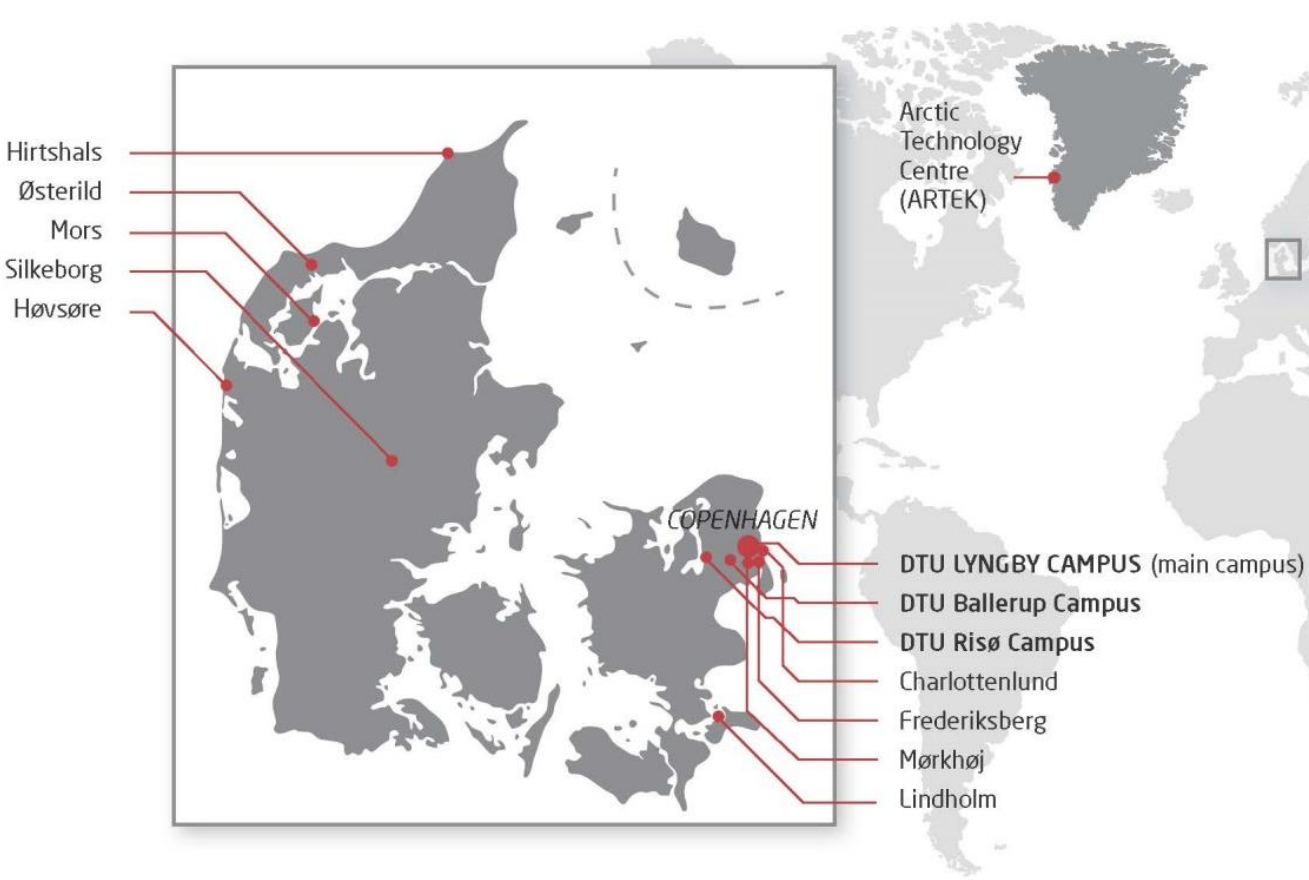
H.C. Ørsted, founder of DTU in 1829



Education	Innovation	Scientific advice

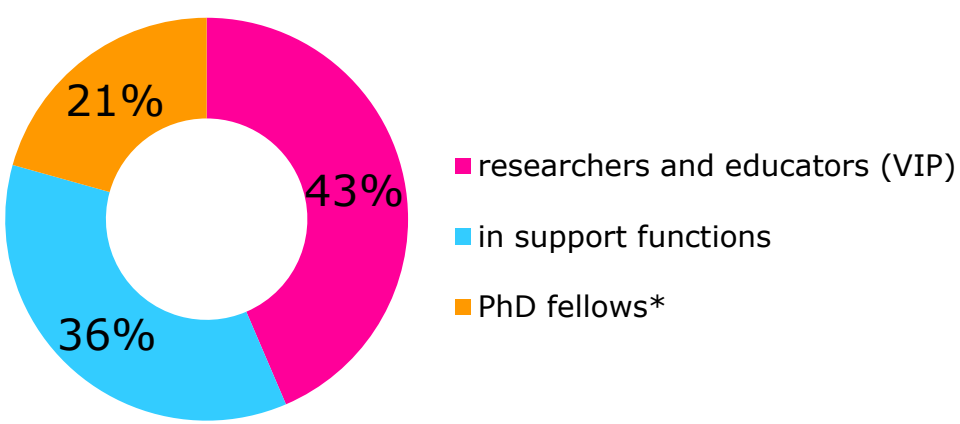
Research

Technical University of Denmark - DTU



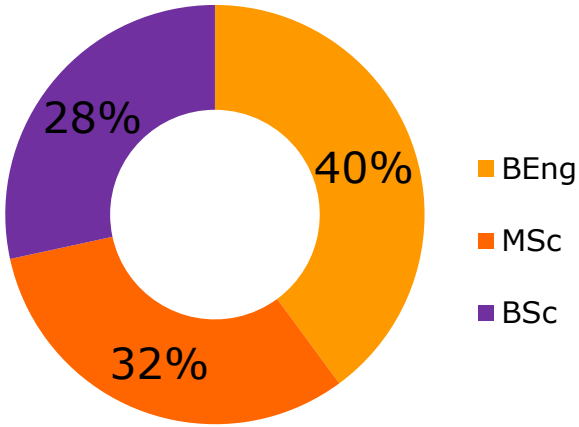
Technical University of Denmark - DTU

5,895
human resources (FTEs)



*Employees only

11,031
full-time students



DTU Electrical Engineering

Power engineering

Automation, control, and robotics

Biomedical engineering, CMR, ultra sound

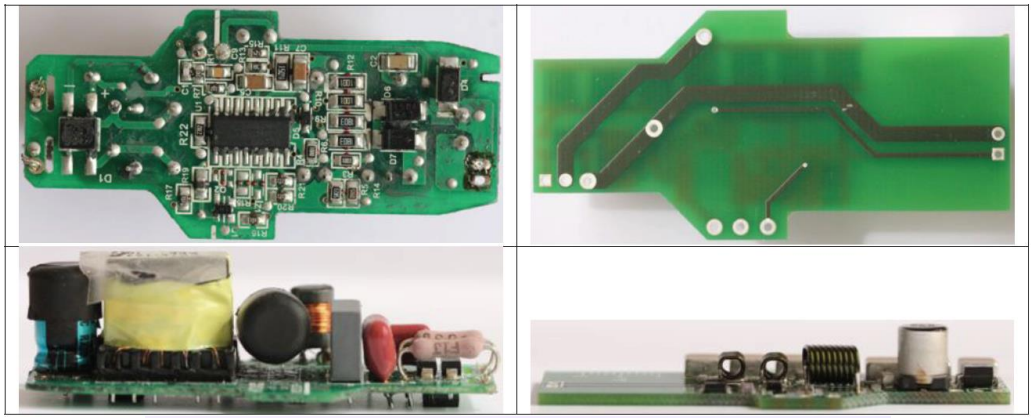
Antennas & microwave tech.

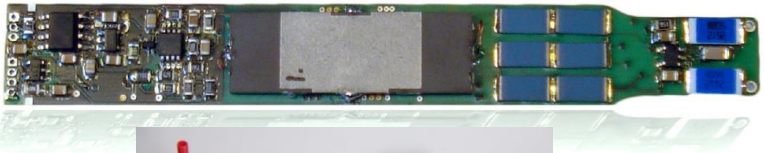
Acoustics

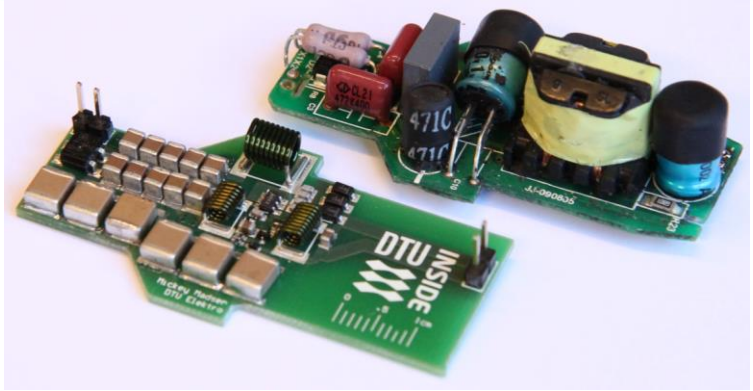
Hearing systems

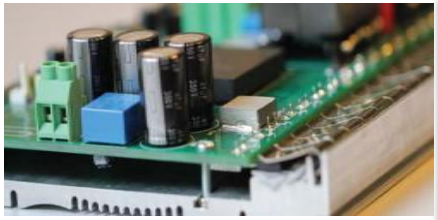
Power electronics & IC design

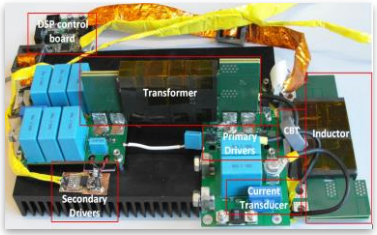
Electronics group











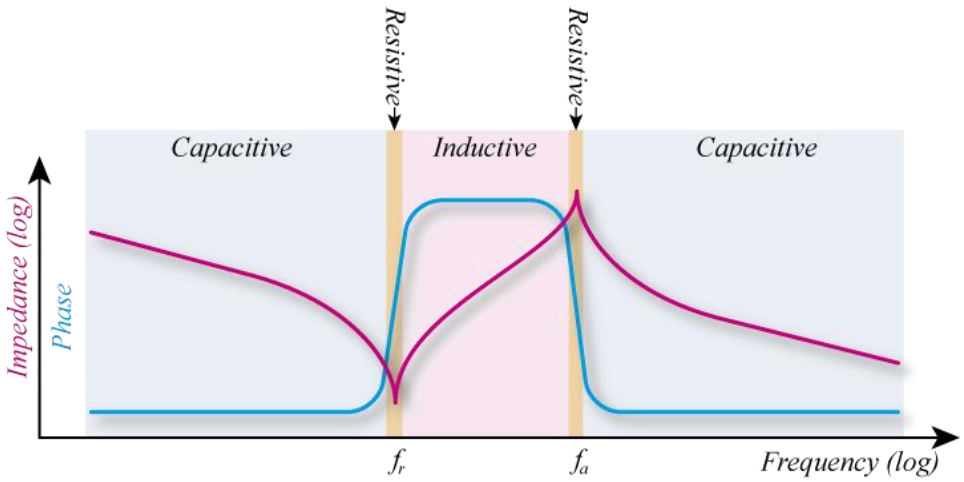
Electronics group

- Is **research leader** within:
  - Switch-mode (class D) Audio power amplifiers
    - 3 spin-off's: B&O ICEpower & TI Denmark & Merus Audio
    - Highest output power IC class-D amplifier chip ever
  - High efficiency fuel cell power converters
    - Has the **highest efficiency** (> 98%) fuel-cell power converter ever
  - VHF power converters

- Provides **unique solutions** to the collaborating companies
- One of the most **innovative groups** at DTU:
  - 46 inventions
  - Start-up companies:
    - ICEpower (former Bang & Olufsen ICEpower)
    - Texas Instruments DK (former Toccata)
    - Upcon Technology
    - Merus Audio
    - Nordic Power Converters
    - Senserna
    - Nordic Firefly

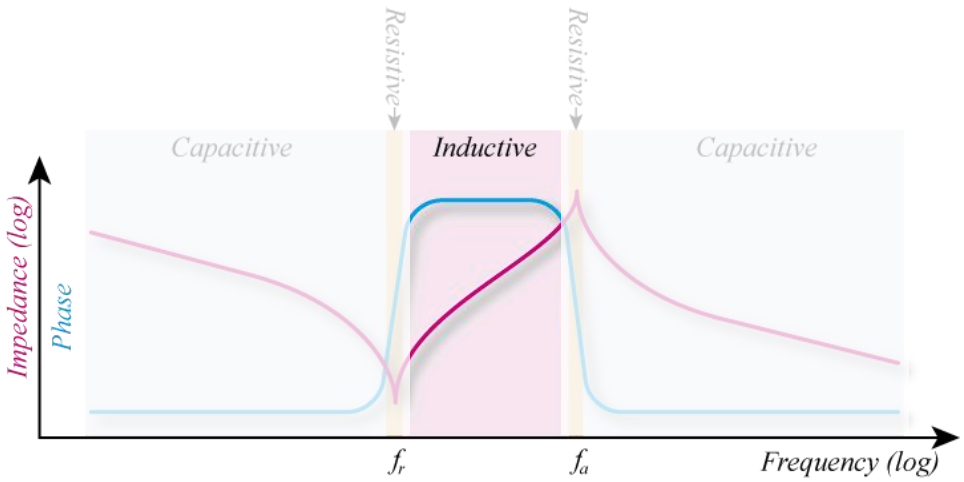
Electrical behaviour of piezos

- **Capacitive behavior**
- **Inductive behavior**
- **Resistive behavior**

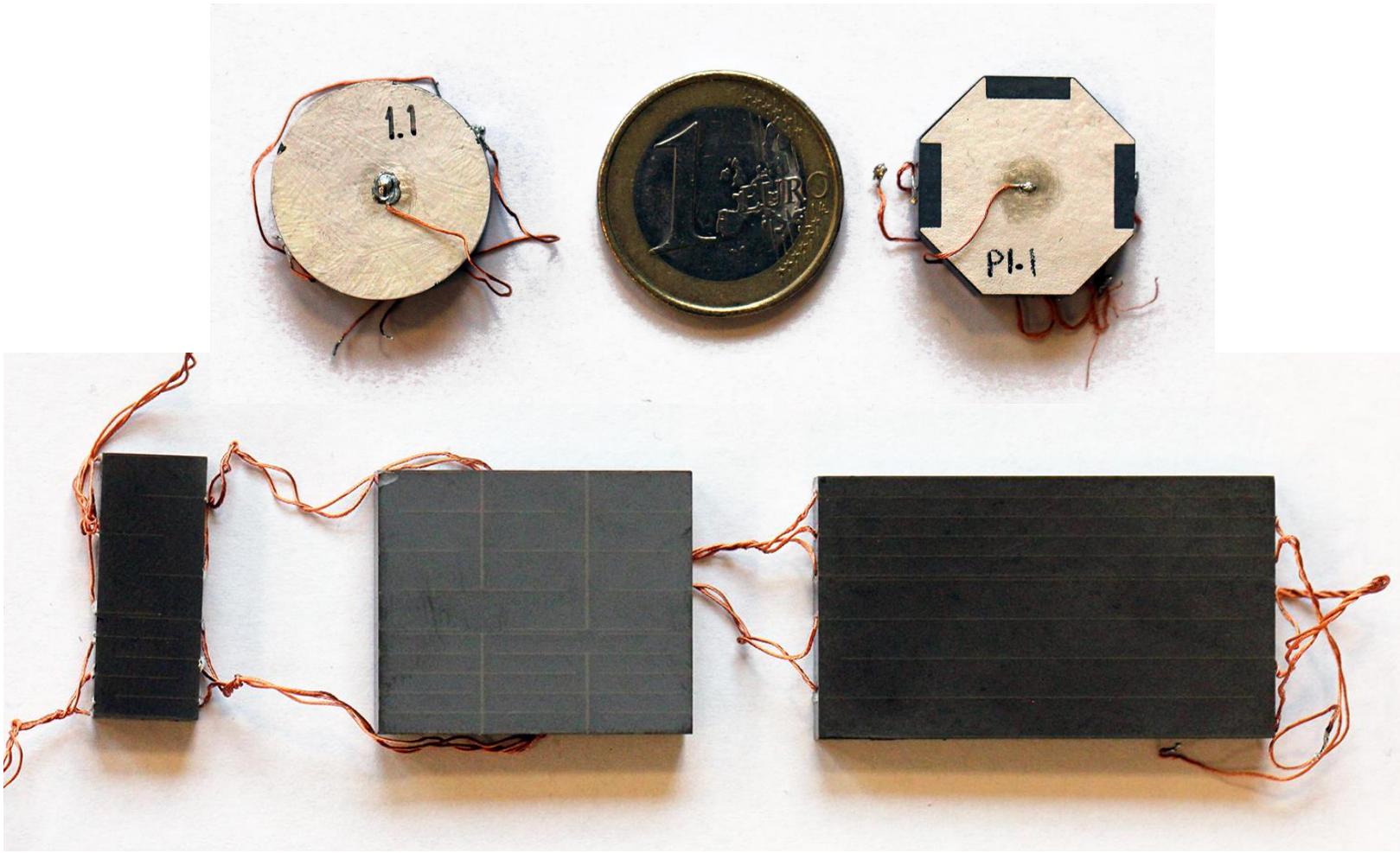


Inductive behaviour of piezos

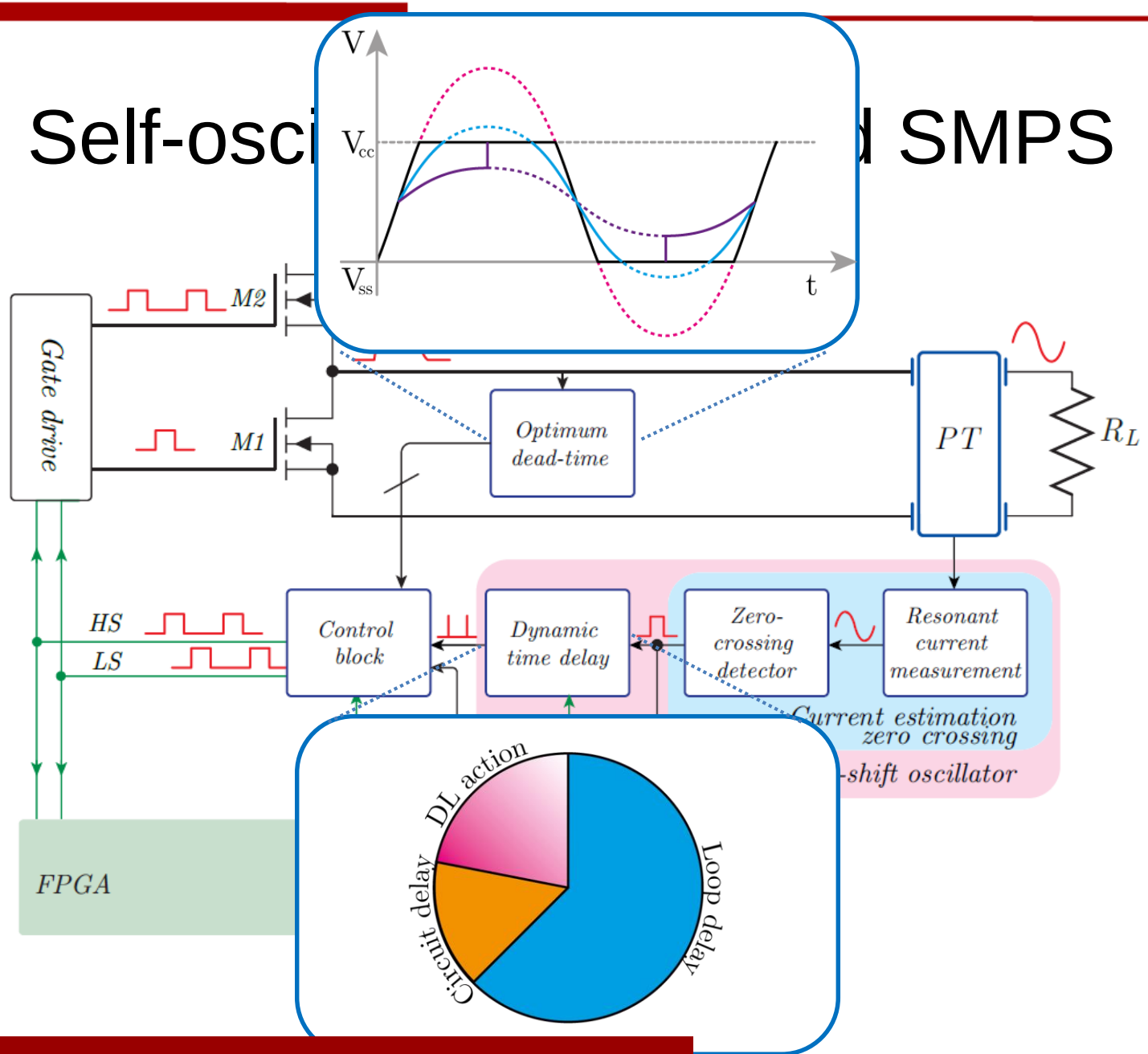
- Intro
- Capacitive behavior
- **Inductive behavior**
- Resistive behavior
- Conclusions



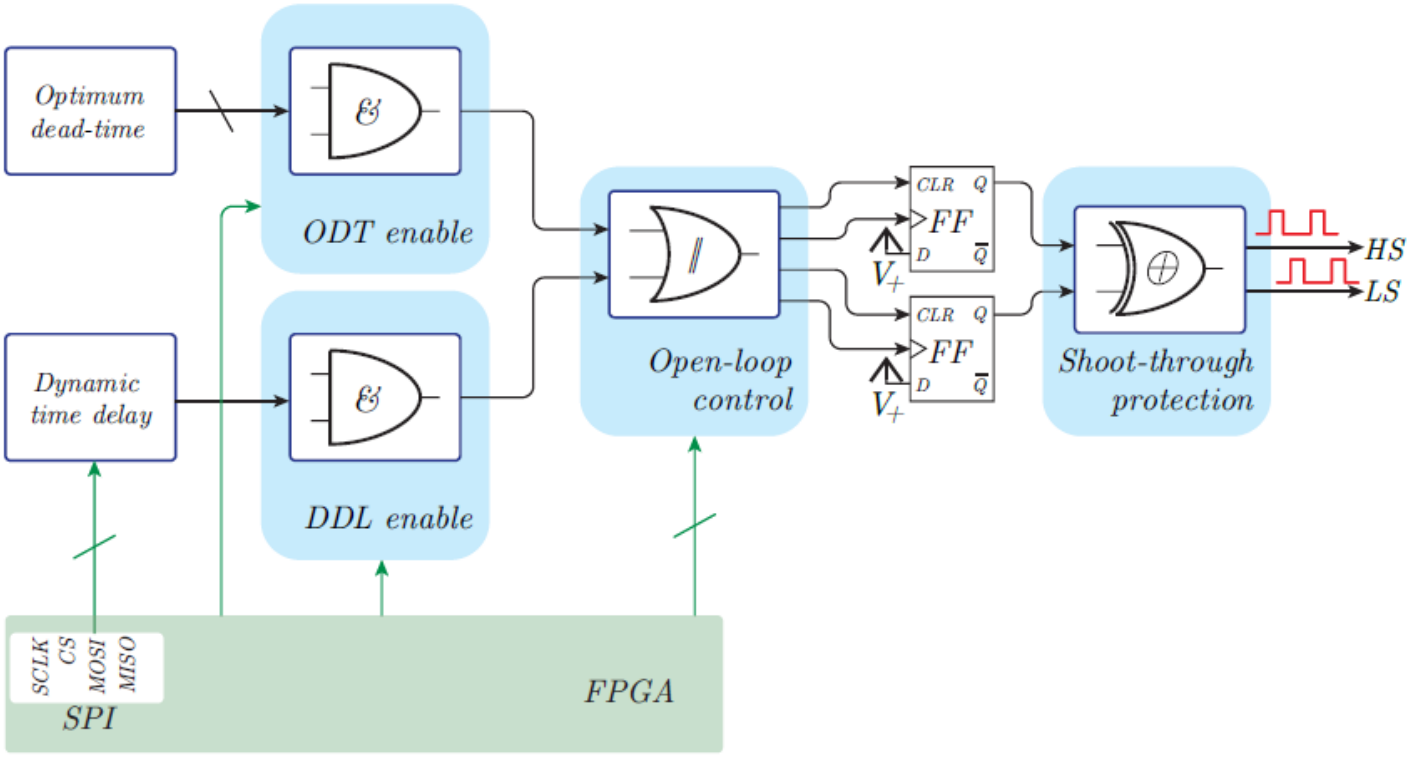
Piezoelectric transformers



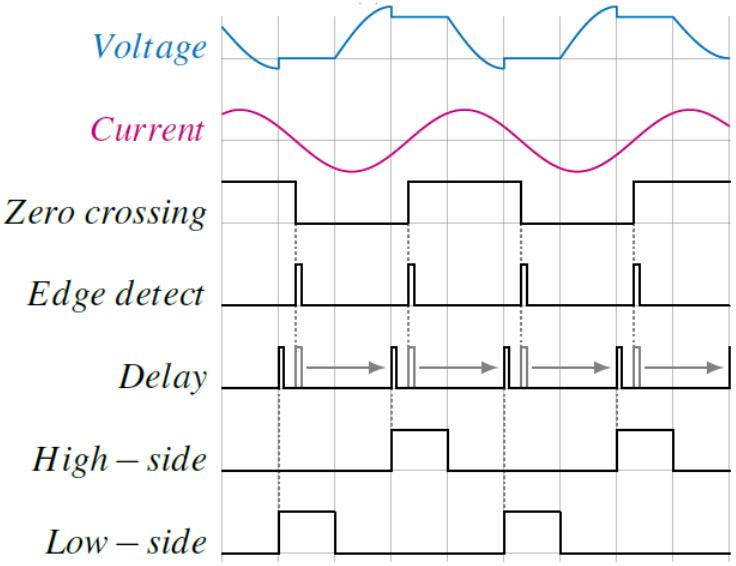
Self-osci d SMPS

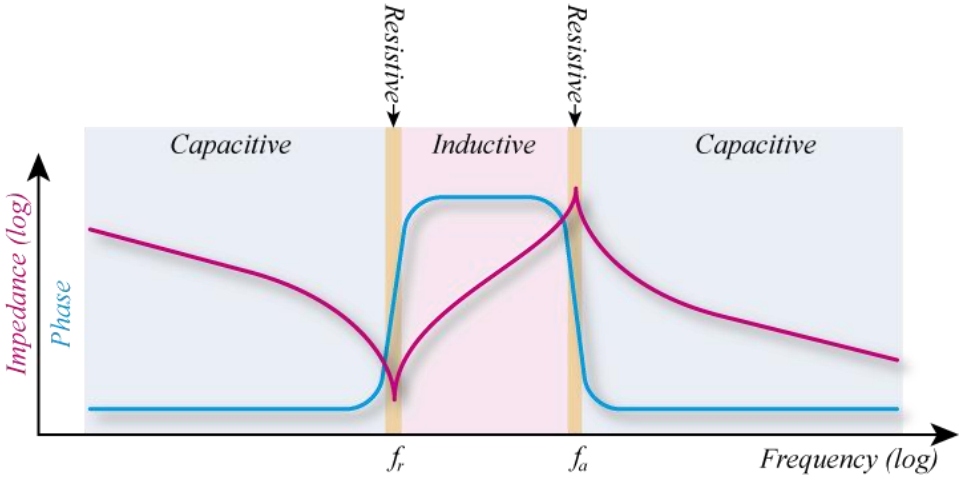


Control block

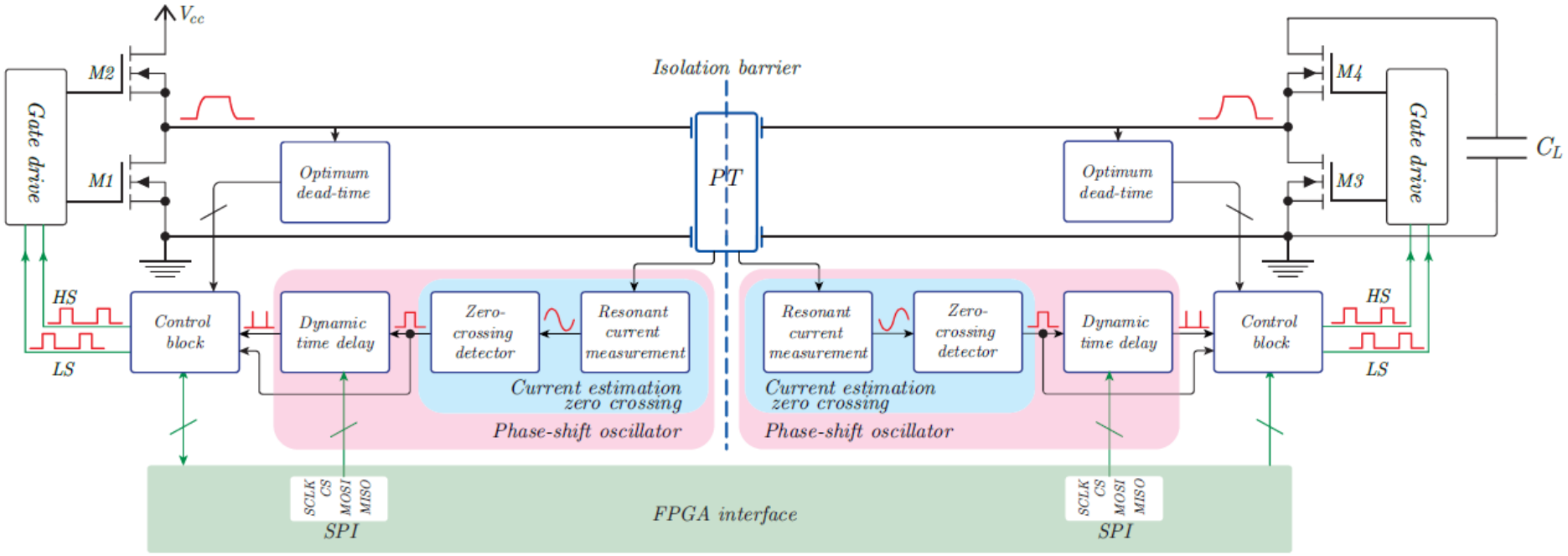


SO Principle

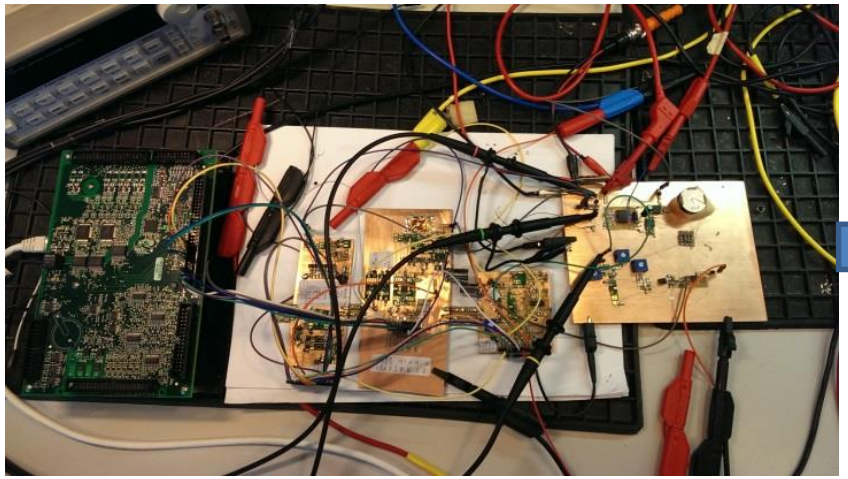


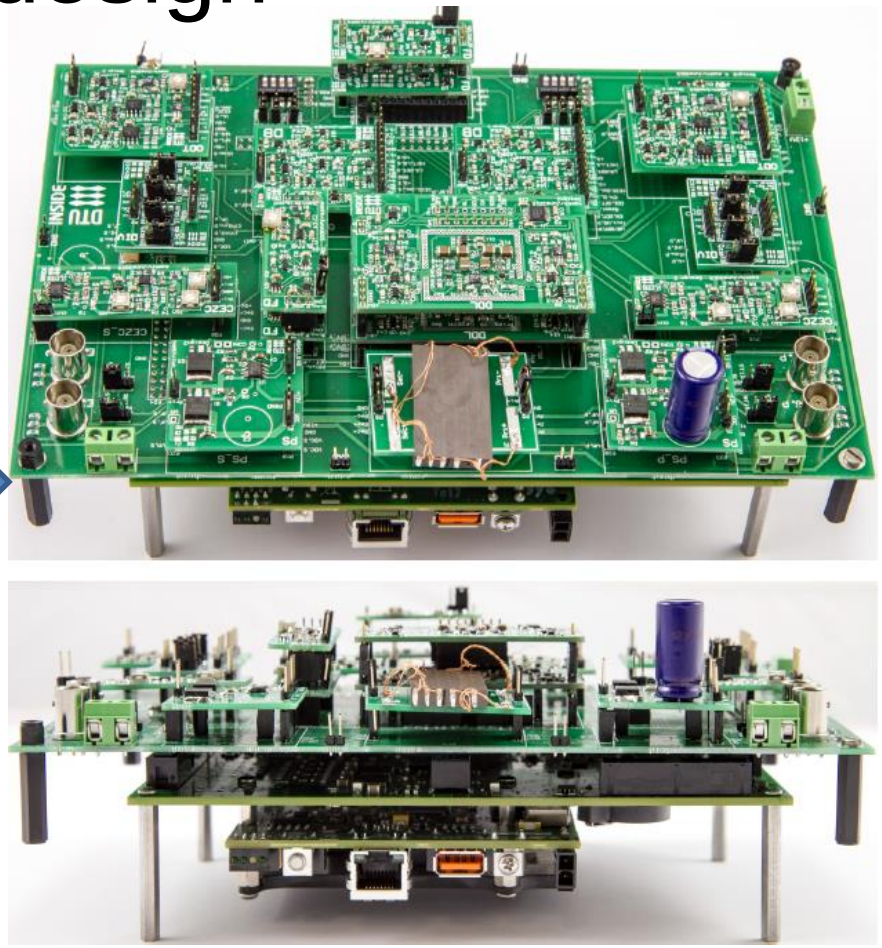


Bidirectional operation



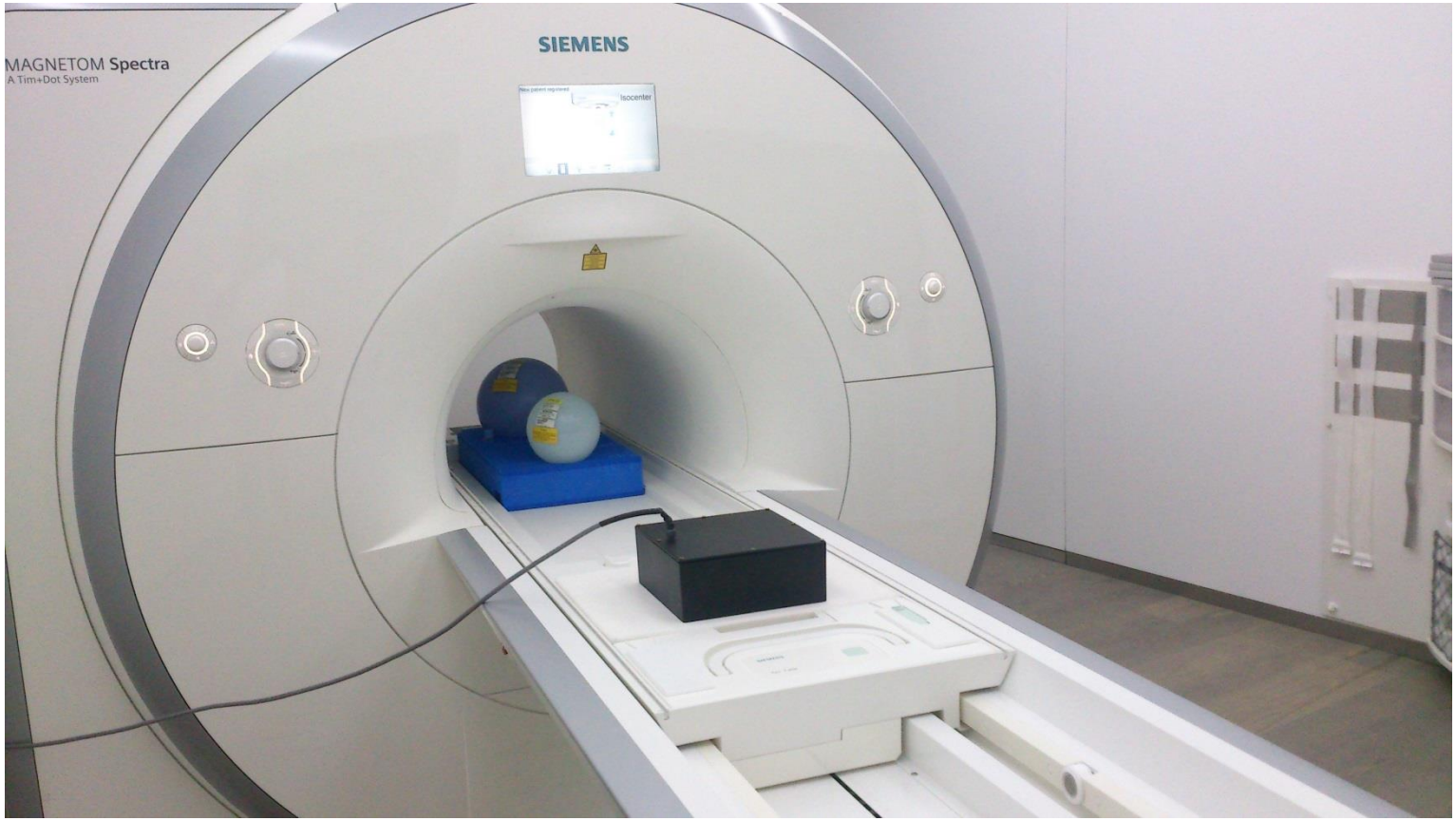
Modular design



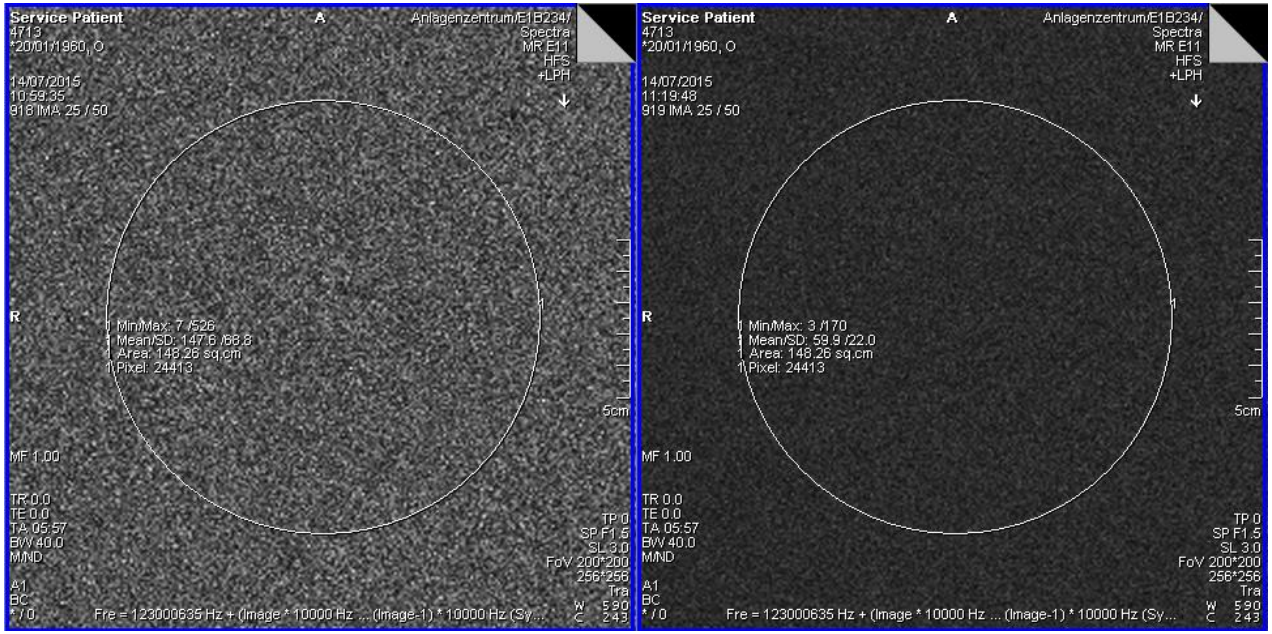


Why inductorless?

MRI testing



MRI testing

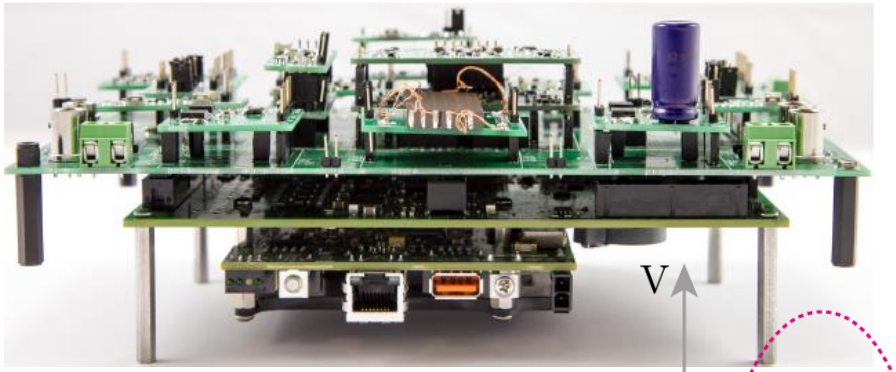


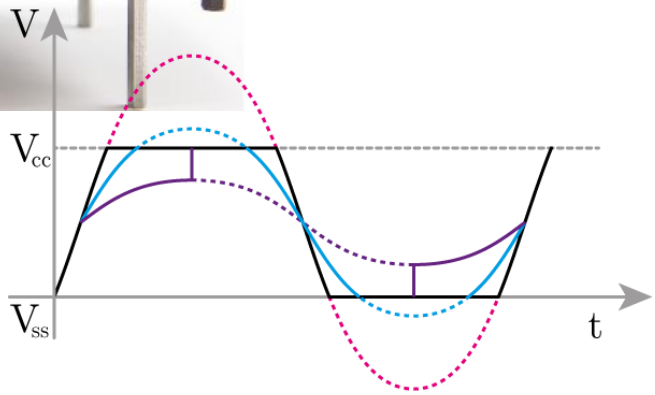
SNR degradation of 10dB

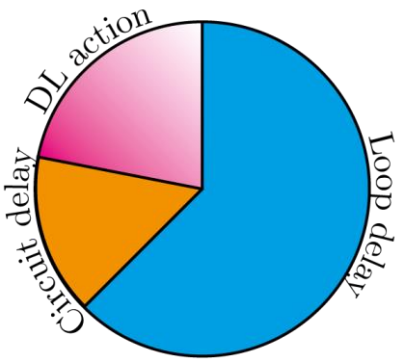
Conclusions

PT-based SMPS control method:

- Simple method for minimizing hard-switching losses
- Fast control to track and maintain self-oscillation







Thank you for your attention!